Daphnia as a Biosensor: Understanding the Sensory Biology of a Sentinel Species for Improved Toxicological Assessments

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Aquatic organisms are experts at detecting both physical and chemical cues within their surroundings. Studies have shown that zooplankton respond to environmental changes in a variety of ways, including phenotypic plasticity over generations, gradual physiological regulations, and visible behavioral responses. Since observations suggest that behavioral responses are immediate, then designing a system that detects these changes as they occur may be the most direct way of identifying relevant environmental cues for the animal and help with assessing the effects of chemicals, such as emerging contaminants, on the organism.

The main goal of my research is to describe the sensory biology of the sentinel species, *Daphnia*, for effective real-time toxicological assessment of waterborne chemicals. Since the early 1980s, daphnids have been utilized for assessing chronic and acute effects of toxins by the U.S. Environmental Protection Agency (U.S. EPA) and other government agencies throughout the world. However, our knowledge of the sensory biology of *Daphnia* has not been explored and, to date, little is known about their abilities to detect chemicals. Although discussions have ensued about the possible chemosensory attributes of *Daphnia*, no one has looked for chemosensory structures or studied their neurobiology. Therefore, no one has linked behavioral response with chemosensory ability. I intend to further our knowledge of this bioindicator species' sensory biology by investigating its neurobiology and looking at the immediate behavioral and physiological response of the organism when exposed to different toxins. Another goal of this research is to use sensory biology in developing a method that monitors real-time effects of toxins on *Daphnia*. Through the integration of analytical chemistry, behavioral biology, and optical techniques, I have developed a system that can, in near real time, assess the immediate behavioral and physiological response of *Daphnia* when exposed to changing environmental conditions, thereby serving as an early warning system when performing toxicological assessments. The system monitors the intricate feeding apparatus and heart

rate of the organism as the exposure takes place. My main hypothesis is that *Daphnia* have chemoreceptors that allow them to respond immediately to changing chemical conditions and that these immediate responses manifest themselves behaviorally and physiologically. This system will improve our use of *Daphnia* as a model organism and reinforce its status as “canary of the lake.”